CITY OF NEWARK
Delaware

CONTRACT NO. 13-13

CURTIS PAPER MILL REMEDIATION AND PARK CONSTRUCTION

ADDENDUM NO. 3

November 6, 2013

1. Please find attached the following documents:

    a. Memorandum describing changes to the bid proposal form and responses to contractor questions for the Curtis Paper Mill Remediation and Park Construction project.
    b. Revised Proposal Pages C1 – C7
    c. NIOSH Method 0600 Document that pertains to one of the contractor questions

Pennoni

PENNONI ASSOCIATES INC.
CONSULTING ENGINEERS

MEMORANDUM

TO: Charlie Emerson, Director

FROM: William Wendling, P.E.

DATE: November 6, 2013

SUBJECT: Former Curtis Paper Mill Site Park Improvement Project Addendum 3

Attached is a revised Bid proposal form for the project (pages C-1 through C-7), the following changes have been made to the form:

- Added additional total bid line to page C-1 to include line for add/deduct alternate
- Deleted Item 51H – Traffic control device equipment turn on, pick up, removal & maintenance, type I
- Deleted Item 51I - Traffic control device equipment turn on, pick up, removal & maintenance, type I
- Deleted Item 51J – Bonding and grounding of existing junction wells
- Added Item 62 – Air Monitoring
- Revised Items 31A – Seed Mix 'A' Meadow Grass and Item 31C – Seed Mix 'C' Lawn in Add/Deduct Alternates for Planting to clarify that these two items are a deduct item from the base bid. The plantings proposed in the alternate will take the place of these seed mix areas and therefore reduce the quantity needed of each.

Responses to bidder questions with the original questions included are below:

From Reybold Construction:

Questions Dated October 25, 2013:

1) *For excavation, consolidation and capping of contaminated materials, does the city of Newark require the heavy equipment operator and support workers to have 40 hour HAZWOPER Training?*

   As responded to in RFI #2, all workers with potential physical exposure to the soil and/or dust generated during the excavation, consolidation and capping of the metals and PAH contaminated soils are required to be 40 Hour HAZWOPER trained.

2) *Does the project require the need for DNREC HSCA-certified contractors for handling of the contaminated materials?*

No.

3) *Will the contractor be required to provide the Project Environmental Consultant for sampling and material management?*

No, the Project Environmental Consultant for sampling and material management is Pennoni Associates, Inc., on behalf of the City of Newark, DE.

4) *What is the size and existing contents of the storage tank to be demo'd?*

The Above Ground Storage Tank (AST) identified to be removed as part of the contract is a former water tank. The size is approximately eight (8) feet in diameter and fifteen (15) feet in height. The AST is void of any contents.

5) *Item Number 68 of the Bid Proposal is for "Remove/Adjust/Install Monitoring Wells"; what are the construction specifications of the existing and proposed wells?*

The Contractor is NOT responsible for any adjustment/ removal or installation of monitoring wells on the site. The City's Project Environmental Consultant shall be responsible for this scope of work. However, the Contractor "IS" responsible to locate and identify the site groundwater monitoring wells and protect them from damage during the course of their site activities. Any monitoring well damaged as a result of the Contractor's work, shall be repaired/replaced by the Contractor at no cost to the City or DNREC.

6) *Equipment Decontamination; Can the base of the decontamination pad be constructed with gravel / rip-rap or is a pre-fabricated wash-rack required?*

The equipment decontamination pad is required to include a wash-down station with wash run-off controls and mud control procedures to prevent the spread of contamination from the soil that is washed from all equipment and vehicles prior to leaving the site. These precautions must be undertaken to prevent the spread of contamination onto/into non-contaminated areas, including non-contaminated soil or other surfaces, drains, stormwater inlets, uncontaminated impervious areas, neighboring properties including access roads and highways, etc. Contractors are required to submit a detailed equipment decontamination plan outlining such controls, for Owner's review and approval prior to the start of the work. The design of the station, wash run-off controls and mud control procedures is at each Contractor's discretion.

7) *I believe this was touched on at the meeting, but I'll be the guy to ask it again!: Item 62 – Air Monitoring – Respirable Particulates; Under Requirement B it states that sampling methodology is to follow NIOSH Method 5506 and Method 7300, but analytical requirements only indicate NIOSH Method 0600.*

a. *Will laboratory analysis following Method 5506 and 7300 be required?*

As a clarification, all monitoring and analysis for "fugitive dust" shall be conducted following NIOSH Method 0600 - PARTICULATES NOT OTHERWISE REGULATED, RESPIRABLE which outlines the type of sampler, type of filter, flow rate and volume. A copy of NIOSH Method 0600 is attached.

b. *If so, how many, at what frequency, and what required turn-around time for results from the lab?*

As discussed at the Pre-bid, the Contractor is responsible for dust control during the length of the project. The Contractor will need to demonstrate that their dust control measures are effective and demonstrable over a number of days. The Project Environmental Consultant acknowledged that a minimum of three (3) days of data per work area region would be required; however, the Contractor shall understand and be responsible for the cost of and the sampling and analysis on any additional day(s) over the minimum, as deemed appropriate by the Project Environmental Consultant based on dust levels and/or weather conditions the day of the site activities. The sample frequency shall be as stated in Item 62 – AIR MONITORING – RESPIRABLE PARTICULATES, EXECUTION, A – Sample Frequency. Turn-around time shall be such that results are available and on-site prior to the start of the next day work-shift.

c. *Will results for respirable particulate samples (Method 0600) be field calculated daily and presented in the daily report?*

Samples will be required to be submitted to a DNREC approved laboratory for analysis.

From Mumford & Miller Concrete, Inc.

- *What is to be included in bid Item 66 (Traffic Statement)?*

Item 66 has been removed from the bid proposal as this work is to be done by DelDOT's traffic contractor.

- *What is the significance of "Attachment 2 Traffic Statement"? Are we to include the cost shown on the attachment ($115,137.75) in the bid?*

The attachment is shown for informational purposes only. This work is to be done by DelDOT's traffic contractor. Contractor is to familiarize themselves with what is

included in the traffic statement. Refer to page 2, bullet item number 4 of the Former Curtis Paper Mill Site Park Improvement Project Addendum memorandum dated October 29, 2013 for work that the site contractor is responsible related to the traffic signalization.

- *What is to be included in bid Item 67 (Utility Adjustments/Relocations)?*

  All utility adjustments/relocations associated with the entrance construction are to be included under this bid item. Refer to Commercial Entrance plans for utilities to be adjusted/relocated and General Notes 9, 10, and 16 on sheet 1 of 12 and General Note 5 on sheet 2 of 12.

From Eastern States Construction:

Questions Dated November 5, 2013:

- *On the bid form, it requests a "bid price" Is this inclusive or exclusive of the alternates.*

  Attached is a revised Bid proposal form for the project (pages C-1 through C-7) which delineates how this project is to be bid.
  The general format is as follows:

  Curtis Paper Mill Remediation and Park Construction $_____
  Add/Deduct Alternates Total $_____
  Total Amount of Bid (Including Add/Deduct Alternates) $_____

- *Additionally, can you please provide more detail on what is required for documentation of the mill race.*

  The contractor is required to expose the existing mill, document the conditions, material and how it is to be filled in. The general alignment is to be red-lined on a plan so the City has a general idea as to the alignment for future needs.

CITY OF NEWARK

Delaware

CONTRACT NO. 13-13

CURTIS PAPER MILL REMEDIATION AND PARK CONSTRUCTION

PROPOSAL

To: The Mayor and City Council
Newark, Delaware

From: _____

The undersigned as a lawfully authorized agent for the below named bidder has carefully examined the Bid Documents to be known as Contract No. 13-13 and binds himself on award to him by the Mayor and City Council of Newark, Delaware to execute in accordance with such award, a contract of which this Proposal and said General Provisions and Specifications and any Addenda shall be a part, and to furnish the goods as specified F.O.B. Newark, Delaware in a manner that is in complete accordance with said General Provisions and Specifications at the following named unit price on or before the delivery period stated below:

Bid Item	Item Description	Amount
1	Curtis Paper Mill Remediation And Park Construction	$_____
	Add/Deduct Alternates Total	$_____
	Total Bid (Including Add/Deduct Alternate)	$_____

CITY OF NEWARK

Delaware

CONTRACT NO. 13-13

CURTIS PAPER MILL REMEDIATION AND PARK CONSTRUCTION

PROPOSAL

Project to be Completed by _____

DATE: _____ BIDDER: _____

By: _____
Its legally authorized representative

PRINT NAME: _____

TITLE: _____

ADDRESS: _____

CITY, STATE, ZIP: _____

TELEPHONE: _____

BIDDER _____

BID PROPOSAL FOR CITY OF NEWARK CONTRACT NO. 13-13
CURTIS MILL PARK

Item Number	DESCRIPTION	UNIT	UNIT PRICE	QUANTITY	COST
	CONTRACTOR MOBILIZATION	LS		1	
1	CLEARING AND GRUBBING, MISC. DEMO	AC		4	
1	RELOCATE EXISTING SOIL PILES TO CONSOLIDATION AREA	LS		1	
2	EXCAVATION & EMBANKMENT				
	SITE EARTHWORK	CY		12000	
	ENTRANCE IMPROVEMENTS	CY		297	
2A	EROSION AND SEDIMENT CONTROL	LS		1	
2E	UNDERCUT EXCAVATION	CY		70	
4	SELECTIVE DEMO OF EXISTING CONCRETE BUILDING PAD	LS		1	
5A	GRADED AGGREGATE BASE COURSE, TYPE B				
	UNDER SITE PAVEMENT	CY		463	
	UNDER SITE WALKING PATH	CY		105	
	UNDER SITE SIDEWALK	CY		27	
	UNDER PCC 1-6 CURB	CY		3	
	UNDER PLAZA CONCRETE	CY		16	
	ENTRANCE IMPROVEMENTS	CY		185	
5B	BORROW, TYPE A	CY		70	
6	SELECTIVE DEMO OF EXISTING BITUMINOUS PAVEMENT	LS		1	
6	REMOVE EXISTING STORAGE TANKS	ALLOWANCE		1	
6	REMOVAL OF EXISTING UNDERGROUND PIPES AND STRUCTURES	LS		1	
17	REINFORCED CONCRETE PIPE, 18", CLASS IV	LF		6	
21B	CORRUGATED POLYETHYLENE PIPE, TYPE S, 18" DIAMETER	LF		248	
21C	CORRUGATED POLYETHYLENE PIPE FLARED END SECTION, 18" DIAMETER	EACH		3	

BIDDER _____

BID PROPOSAL FOR CITY OF NEWARK CONTRACT NO. 13-13
CURTIS MILL PARK

Item Number	DESCRIPTION	UNIT	UNIT PRICE	QUANTITY	COST
21D	PERFORATED SCH. 40 PVC UNDERDRAIN, INCLUDING FILTER FABRIC AND DE NO. 57 STONE	LF		256	
25C	PCC 1-8 CURBING	LF		711	
25D	PCC 1-6 CURBING	LF		193	
26	CONCRETE SIDEWALK				
	ON-SITE (CAP) - 4" 3,500 PSI WITH FIBER REINFORCEMENT	SF		3800	
	ENTRANCE IMPROVEMENTS	SF		811	
26B	CURB RAMP, TYPE 2, 3 AND/OR 4	SF		340	
26C	SIDEWALK SURFACE DETECTABLE WARNING SYSTEM	SF		40	
26D	CURB RAMP, TYPE 1	SF		101	
27A	DRAINAGE INLET, 34" X 24"	EACH		1	
27B	DRAINAGE INLET, 48" X 30"	EACH		1	
27C	ADJUSTING AND REPAIRING EXISTING DRAINAGE INLET	EACH		3	
27D	ADJUST AND REPAIR EXISTING SANITARY MANHOLE	EACH		1	
27E	CLEANING DRAINAGE PIPE, 15"-24" DIA.	LF		86	
29	IMPORT AND SPREAD TOPSOIL				
	(CAP) - 6" DEPTH	CY		2300	
	ENTRANCE IMPROVEMENTS	CY		75	
31	PERMANENT GRASS SEEDING ENTRANCE IMPROVEMENTS	SY		445	
31A	SEED MIX 'A' MEADOW GRASS	SY		15786	
31B	SEED MIX 'B' WETLAND MEADOW	SY		6611	
31C	SEED MIX 'C' LAWN	SY		4659	
37B	RIPRAP, R-4	TON		27	
39A	WMA, SUPERPAVE, TYPE C, 160 GYRATIONS, PG 76-22 (CARBONATE STONE)	TON		514	
39B	WMA, SUPERPAVE, TYPE B, 160 GYRATIONS, PG 76-22	TON		128	

BIDDER _____

BID PROPOSAL FOR CITY OF NEWARK CONTRACT NO. 13-13
CURTIS MILL PARK

Item Number	DESCRIPTION	UNIT	UNIT PRICE	QUANTITY	COST
39C	WMA, SUPERPAVE, BITUMINOUS CONCRETE BASE COURSE,160 GYRATIONS, PG 64-22	TON		347	
39D	SAW CUTTING	LF		1062	
39E	WMA, SUPERPAVE, TYPE C, 160 GYRATIONS,PG 64-22	TON		387	
39F	WMA, SUPERPAVE, TYPE B, 160 GYRATIONS, PG 64-22	TON		473	
46	PAVEMENT MILLING	SY-IN		3771	
47	GEOTEXTILES	SY		2775	
49A	PERMANENT PAVEMENT STRIPING, EPOXY RESIN PAINT, WHITE/YELLOW, 5"	LF		4073	
49B	PERMANENT PAVEMENT STRIPING, SYMBOL/LEGEND, ALKYD-THERMOPLASTIC	SF		1001	
49B	PERMANENT PAVEMENT STRIPING, ALKYD-THERMOPLASTIC, PARKING AREA, BLUE/WHITE 5"	LF		360	
49C	PREFORMED RETROREFLECTIVE THERMOPLASTIC PAVEMENT MARKINGS, BIKE SYMBOL	EA		6	
50A	INSTALLATION OR REMOVAL OF TRAFFIC SIGN ON SINGLE SIGN POST	EA		10	
50A	INSTALLATION OF VAN ACCESSIBLE DISABLED PARKING SIGN	EA		1	
50B	INSTALLATION OR REMOVAL OF TRAFFIC SIGN ON MULTIPLE SIGN POSTS	SF		4	
51A	ADJUST OR REPAIR EXISTING CONDUIT JUNCTION WELL	EA		2	
51B	CONDUIT JUNCTION WELL, TYPE 11	EA		4	
51C	CONDUIT JUNCTION WELL, TYPE 14	EA		1	
51D	FURNISH & INSTALL UP TO 4" SCHEDULE 80 PVC CONDUIT (TRENCH)	LF		182	
51E	FURNISH & INSTALL LOOP WIRE 1-CONDUCTOR #14 AWGENCASED IN ¼" FLEXIBLE TUBING IN A LOOP SAWCUT	LF		1277	

BIDDER _____

BID PROPOSAL FOR CITY OF NEWARK CONTRACT NO. 13-13
CURTIS MILL PARK

Item Number	DESCRIPTION	UNIT	UNIT PRICE	QUANTITY	COST
51F	POLE BASE TYPE 3	EA		4	
51G	POLE BASE TYPE 4	EA		2	
52	REMOVAL OF EXISTING PORTLAND CEMENT CONCRETE PAVEMENT, CURB, SIDEWALK, ETC.	SY		1250	
54	PIPE VIDEO INSPECTION	LF		86	
55	FIELD OFFICE - TYPE II	EAMO		1	
56	PROJECT CONTROL SYSTEM DEVELOPMENT PLAN	LS		1	
57	CPM SCHEDULE UPDATES AND/OR REVISED UPDATES	EAMO		3	
58	MAINTENANCE OF TRAFFIC	LS		1	
59	CONSTRUCTION ENGINEERING	LS		1	
60	SITE FURNISHINGS				
	PICNIC TABLE TYPE 'A'	EA		1	
	PICNIC TABLE TYPE 'B'	EA		1	
	PEDESTRIAN BENCHES TYPE 'C'	EA		2	
	INFORMATION SIGN	EA		3	
	BICYCLE HITCHING STATION	EA		6	
	PARKING STOPS	EA		14	
	BRICK PIERS (2)	LS		1	
61A	CONCRETE PAVER AND SAND FOR PLAZA (CAP)	SF		1662	
61B	BLUESTONE PAVERS FOR PLAZA (CAP)	SF		64	
61B	PLAZA CONCRETE EDGE RESTRAINT WITH (2) #4 REBAR REINFORCEMENT	LF		151	
62	AIR MONITORING	LS		1	
63	IMPORT CLEAN FILL FOR FILLING OF FORMER RACEWAY	CY		500	

BIDDER _____

BID PROPOSAL FOR CITY OF NEWARK CONTRACT NO. 13-13
CURTIS MILL PARK

Item Number	DESCRIPTION	UNIT	UNIT PRICE	QUANTITY	COST
64	EARTHWORK (CONTAMINATE SOIL EXCAVATION AND RELOCATION)	LS		1	
67	UTILITY ADJUSTMENTS/RELOCATIONS	LS		1	
68	REMOVE/ADJUST/INSTALL MONITORING WELLS	EA		4	

TOTAL AMOUNT OF BID = _____

BID PROPOSAL FOR CITY OF NEWARK CONTRACT NO. 13-13
CURTIS MILL PARK - ADD/DEDUCT ALTERNATES FOR PLANTINGS

Item Number	DESCRIPTION	UNIT	PRICE	UNIT QUANTITY	COST
31A	SEED MIX 'A' MEADOW GRASS (DEDUCT)	SY		(-121)	
31C	SEED MIX 'C' LAWN (DEDUCT)	SY		(-287)	
32	MULCHING	SY		409	
65	PLANTING				
	'GREEN MOUNTAIN' SUGAR MAPLE (2-2 1/2" CAL.)	EA		3	
	AMERICAN SWEETGUM 'ROTUNDILOBA' (2-2 1/2" CAL.)	EA		5	
	BLACK GUM (2-2 1/2" CAL.)	EA		6	
	'COLUMBIA' LONDON PLANE TREE (2-2 1/2" CAL.)	EA		6	
	SWAMP WHITE OAK (2-2 1/2" CAL.)	EA		10	
	'RED ROCKET' CRAPEMYRTLE (6'-8' HT.)	EA		4	
	WHITE SPRUCE (6'-7' HT.)	EA		5	
	'CENTENNIAL' CRAPEMYRTLE (4'-5' HT.)	EA		5	
	'BLUE MIST' CARYOPTERIS (1 QT. POTS MIN.)	EA		5	
	RED KNOCKOUT ROSE (5 GAL.)	EA		2	
	VARIEGATED LIRIOPE (1 QT.)	EA		2910	
	'TETE-A-TETE' DAFFODIL (BULB)	EA		1000	
	'HAMELIN' PENNISETUM (1 QT.)	EA		17	

TOTAL AMOUNT OF BID (INCLUDING ADD/DEDUCT ALTERNATES) = _____

PARTICULATES NOT OTHERWISE REGULATED, RESPIRABLE 0600

DEFINITION: aerosol collected by sampler with 4-µm median cut point

CAS: None

RTECS: None

METHOD: 0600, Issue 3 **EVALUATION: FULL** **Issue 1: 15 February 1984**
Issue 3: 15 January 1998

OSHA: 5 mg/m³
NIOSH: no REL
ACGIH: 3 mg/m³

PROPERTIES: contains no asbestos and quartz less than 1%; penetrates non-ciliated portions of respiratory system

SYNONYMS: nuisance dusts; particulates not otherwise classified

SAMPLING

SAMPLER: CYCLONE + FILTER (10-mm nylon cyclone, Higgins-Dewell [HD] cyclone, or aluminum cyclone + tared 5-µm PVC membrane)

FLOW RATE: nylon cyclone: 1.7 L/min
HD cyclone: 2.2 L/min
Al cyclone: 2.5 L/min

VOL-MIN: 20 L @ 5 mg/m³
-MAX: 400 L

SHIPMENT: routine

SAMPLE STABILITY: stable

BLANKS: 2 to 10 field blanks per set

ACCURACY

RANGE STUDIED: 0.5 to 10 mg/m³ (lab and field)

BIAS: dependent on dust size distribution [1]

OVERALL PRECISION ($\hat{S}_{rt}$): dependent on size distribution [1,2]

ACCURACY: dependent on size distribution [1]

MEASUREMENT

TECHNIQUE: GRAVIMETRIC (FILTER WEIGHT)

ANALYTE: mass of respirable dust fraction

BALANCE: 0.001 mg sensitivity; use same balance before and after sample collection

CALIBRATION: National Institute of Standards and Technology Class S-1.1 or ASTM Class 1 weights

RANGE: 0.1 to 2 mg per sample

ESTIMATED LOD: 0.03 mg per sample

PRECISION: <10 µg with 0.001 mg sensitivity balance; <70 µg with 0.01 mg sensitivity balance [3]

APPLICABILITY: The working range is 0.5 to 10 mg/m³ for a 200-L air sample. The method measures the mass concentration of any non-volatile respirable dust. In addition to inert dusts [4], the method has been recommended for respirable coal dust. The method is biased in light of the recently adopted international definition of respirable dust, e.g., ≈ +7% bias for non-diesel, coal mine dust [5].

INTERFERENCES: Larger than respirable particles (over 10 µm) have been found in some cases by microscopic analysis of cyclone filters. Over-sized particles in samples are known to be caused by inverting the cyclone assembly. Heavy dust loadings, fibers, and water-saturated dusts also interfere with the cyclone's size-selective properties. The use of conductive samplers is recommended to minimize particle charge effects.

OTHER METHODS: This method is based on and replaces Sampling Data Sheet #29.02 [6].

EQUIPMENT:

1. Sampler:
   a. Filter: 5.0-µm pore size, polyvinyl chloride filter or equivalent hydrophobic membrane filter supported by a cassette filter holder (preferably conductive).
   b. Cyclone: 10-mm nylon (Mine Safety Appliance Co., Instrument Division, P. O. Box 427, Pittsburgh, PA 15230), Higgins-Dewell (BGI Inc., 58 Guinan St., Waltham, MA 02154) [7], aluminum cyclone (SKC Inc., 863 Valley View Road, Eighty Four, PA 15330), or equivalent.
2. Personal sampling pump, 1.7 L/min ± 5% for nylon cyclone, 2.2 L/min ± 5% for HD cyclone, or 2.5 L/min ± 5% for the Al cyclone with flexible connecting tubing.
   NOTE: Pulsation in the pump flow must be within ± 20% of the mean flow.
3. Balance, analytical, with sensitivity of 0.001 mg.
4. Weights, NIST Class S-1.1, or ASTM Class 1.
5. Static neutralizer, e.g., Po-210; replace nine months after the production date.
6. Forceps (preferably nylon).
7. Environmental chamber or room for balance, e.g., 20 °C ± 1 °C and 50% ± 5% RH.

SPECIAL PRECAUTIONS: None.

PREPARATION OF SAMPLERS BEFORE SAMPLING:

1. Equilibrate the filters in an environmentally controlled weighing area or chamber for at least 2 h.
2. Weigh the filters in an environmentally controlled area or chamber. Record the filter tare weight, W_1 (mg).
   a. Zero the balance before each weighing.
   b. Handle the filter with forceps (nylon forceps if further analyses will be done).
   c. Pass the filter over an anti-static radiation source. Repeat this step if filter does not release easily from the forceps or if filter attracts balance pan. Static electricity can cause erroneous weight readings.
3. Assemble the filters in the filter cassettes and close firmly so that leakage around the filter will not occur. Place a plug in each opening of the filter cassette.
4. Remove the cyclone's grit cap before use and inspect the cyclone interior. If the inside is visibly scored, discard this cyclone since the dust separation characteristics of the cyclone may be altered. Clean the interior of the cyclone to prevent reentrainment of large particles.
5. Assemble the sampler head. Check alignment of filter holder and cyclone in the sampling head to prevent leakage.

SAMPLING:

6. Calibrate each personal sampling pump to the appropriate flow rate with a representative sampler in line.
   NOTE 1: Because of their inlet designs, nylon and aluminum cyclones are calibrated within a large vessel with inlet and outlet ports. The inlet is connected to a calibrator (e.g., a bubble meter). The cyclone outlet is connected to the outlet port within the vessel, and the vessel outlet is attached to the pump. See APPENDIX for alternate calibration procedure. (The calibrator can be connected directly to the HD cyclone.)
   NOTE 2: Even if the flow rate shifts by a known amount between calibration and use, the nominal flow rates are used for concentration calculation because of a self-correction feature of the cyclones.
7. Sample 45 min to 8 h. Do not exceed 2 mg dust loading on the filter. Take 2 to 4 replicate samples for each batch of field samples for quality assurance on the sampling procedure (see Step 10).

NOTE : Do not allow the sampler assembly to be inverted at any time. Turning the cyclone to anything more than a horizontal orientation may deposit oversized material from the cyclone body onto the filter.

SAMPLE PREPARATION:

8. Remove the top and bottom plugs from the filter cassette. Equilibrate for at least 2 h in an environmentally controlled area or chamber.

CALIBRATION AND QUALITY CONTROL:

9. Zero the microbalance before all weighings. Use the same microbalance for weighing filters before and after sample collection. Calibrate the balance with National Institute of Standards and Technology Class S-1.1 or ASTM Class 1 weights.
10. The set of replicate field samples should be exposed to the same dust environment, either in a laboratory dust chamber [8] or in the field [9]. The quality control samples must be taken with the same equipment, procedures, and personnel used in the routine field samples. Calculate precision from these replicates and record relative standard deviation (S_r) on control charts. Take corrective action when the precision is out of control [8].

MEASUREMENT:

11. Weigh each filter, including field blanks. Record this post-sampling weight, W_2 (mg), beside its corresponding tare weight. Record anything remarkable about a filter (e.g., visible particles, overloading, leakage, wet, torn, etc.).

CALCULATIONS:

12. Calculate the concentration of respirable particulate, C (mg/m^3), in the air volume sampled, V (L):

$$C = \frac{(W_2 - W_1) - (B_2 - B_1)}{V} \times 10^3, \text{ mg/m}^3,$$

where: W_1 = tare weight of filter before sampling (mg),
W_2 = post-sampling weight of sample-containing filter (mg),
B_1 = mean tare weight of blank filters (mg),
B_2 = mean post-sampling weight of blank filters (mg),
V = volume as sampled at the nominal flow rate (i.e., 1.7 L/min or 2.2 L/min).

EVALUATION OF METHOD:

1. Bias: In respirable dust measurements, the bias in a sample is calculated relative to the appropriate respirable dust convention. The theory for calculating bias was developed by Bartley and Breuer [10]. For this method, the bias, therefore, depends on the international convention for respirable dust, the cyclones' penetration curves, and the size distribution of the ambient dust. Based on measured penetration curves for non-pulsating flow [1], the bias in this method is shown in Figure 1.

   For dust size distributions in the shaded region, the bias in this method lies within the ± 0.10 criterion established by NIOSH for method validation. Bias larger than ± 0.10 would, therefore, be expected for some workplace aerosols. However, bias within ± 0.20 would be expected for dusts with geometric standard deviations greater than 2.0, which is the case in most workplaces.

Bias can also be caused in a cyclone by the pulsation of the personal sampling pump. Bartley, et al. [12] showed that cyclone samples with pulsating flow can have negative bias as large as −0.22 relative to samples with steady flow. The magnitude of the bias depends on the amplitude of the pulsation at the cyclone aperture and the dust size distribution. For pumps with instantaneous flow rates within 20% of the mean, the pulsation bias magnitude is less than 0.02 for most dust size distributions encountered in the workplace.

Electric charges on the dust and the cyclone will also cause bias. Briant and Moss [13] have found electrostatic biases as large as −50%, and show that cyclones made with graphite-filled nylon eliminate the problem. Use of conductive samplers and filter cassettes (Omega Specialty Instrument Co., 4 Kidder Road, Chelmsford, MA 01824) is recommended.

2. Precision: The figure 0.068 mg quoted above for the precision is based on a study [3] of weighing procedures employed in the past by the Mine Safety and Health Administration (MSHA) in which filters are pre-weighed by the filter manufacturer and post-weighed by MSHA using balances readable to 0.010 mg. MSHA [14] has recently completed a study using a 0.001 mg balance for the post-weighing, indicating imprecision equal to 0.006 mg.

   Imprecision equal to 0.010 mg was used for estimating the LOD and is based on specific suggestions [8] regarding filter weighing using a single 0.001 mg balance. This value is consistent with another study [15] of repeat filter weighings, although the actual attainable precision may depend strongly on the specific environment to which the filters are exposed between the two weighings.

REFERENCES:

[1] Bartley DL, Chen CC, Song R, Fischbach TJ [1994]. Respirable aerosol sampler performance testing. Am Ind Hyg Assoc J, *55*(11): 1036–1046.
[2] Bowman JD, Bartley DL, Breuer GM, Shulman SA [1985]. The precision of coal mine dust sampling. Cincinnati, OH: National Institute for Occupational Safety and Health, DHEW (NIOSH) Pub. No. 85-220721.
[3] Parobeck P, Tomb TF, Ku H, Cameron J [1981]. Measurement assurance program for the weighings of respirable coal mine dust samples. J Qual Tech *13*:157.
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METHOD REVISED BY:

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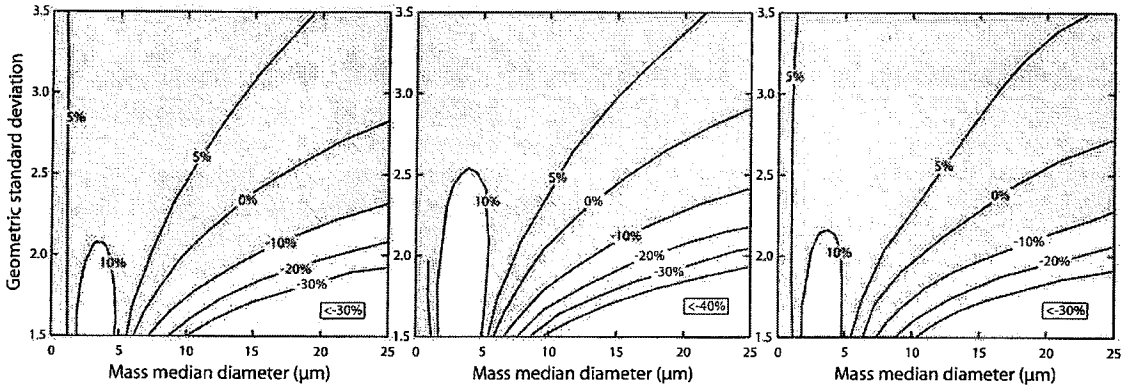

Figure 1. Bias of three cyclone types relative to the international respirable dust sampling convention.

APPENDIX: Jarless Method for Calibration of Cyclone Assemblies

This procedure may be used in the field to calibrate an air sampling pump and a cyclone assembly without using the one-liter "calibration jar".

1. Connect the pump to a pressure gauge or water manometer and a light load (adjustable valve or 5-µm filter) equal to 2" to 5" H_2O with a "TEE" connector and flexible tubing. Connect other end of valve to an electronic bubble meter or standard bubble tube with flexible tubing (See Fig. 2.1).
   NOTE: A light load can be a 5-µm filter and/or an adjustable valve. A heavy load can be several 0.8-µm filters and/or adjustable valve.
2. Adjust the pump to 1.7 L/min, as indicated on the bubble meter/tube, under the light load conditions (2" to 5" H_2O) as indicated on the pressure gauge or manometer.
3. Increase the load until the pressure gauge or water manometer indicates between 25" and 35" H_2O. Check the flow rate of the pump again. The flow rate should remain at 1.7 L/min ± 5%.
4. Replace the pressure gauge or water manometer and the electronic bubble meter or standard bubble tube with the cyclone having a clean filter installed (Fig. 2.2). If the loading caused by the cyclone assembly is between 2" and 5" H_2O, the calibration is complete and the pump and cyclone are ready for sampling.

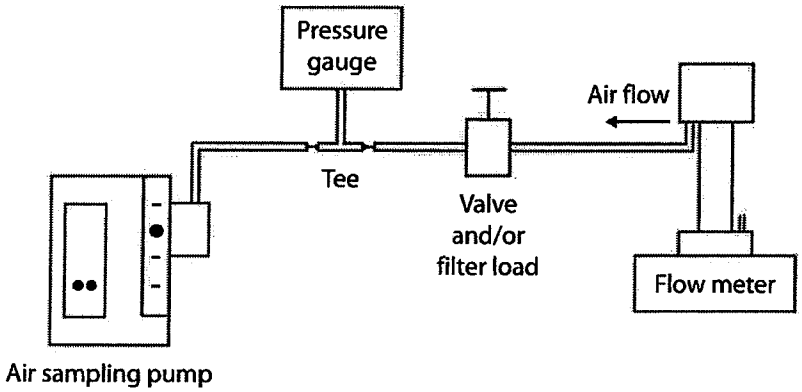

Figure 2.1. Block diagram of pump/load/flow meter set-up.

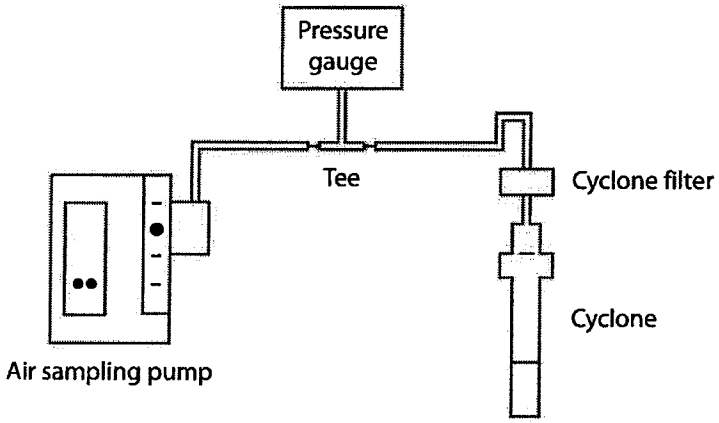

Figure 2.2. Block diagram with cyclone as the test load.